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Georg Hamel and Richard von Mises in Brno

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The article focuses on two outstanding mathematicians who worked at Brno German Technical University, Georg Hamel and Richard von Mises. After their biographies are summarized, their Brno stays are described in detail. A major part of the article is devoted to the process of appointing professors at Brno German Technical University and the difficultie Richard von Mises as a candidate, or those who wanted him to become professor, had to face: he participated in four consecutive competitions for a chair, but without success. © 2002 Elsevier Science (USA)

Der Beitrag ist Georg Hamel und Richard von Mises gewidmet—zwei Mathematikern von Weltrang, welche an der deutschen technischen Hochschule in Brünn tätig waren. Auf eine kurze Zusammenfassung ihrer Lebensläufe folgt eine ausführliche Beschreibung ihrer Aufenthalte in Brünn unter besonderer Beachtung der erfolglosen Bemühungen um die Ernennung von Richard von Mises zum Professor für Mathematik und Mechanik. © 2002 Elsevier Science (USA)

Tento článek je věnován dvěma mimořádným osobnostem světové matematiky, které působily na německé technice v Brně—Georgu Hamelovi a Richardu von Misesovi. V úvodu jsou krátce zmíněny jejich životní osudy a poté je podrobně zachycen jejich brněnský pobyt. Je připomenuto úsilí o Misesovo jmenování profesorem matematiky a mechaniky v Brně. © 2002 Elsevier Science (USA)

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1. INTRODUCTION

The history of the German Technical University (*Deutsche Technische Hochschule*) in Brno and its position firs in Austro-Hungarian and later in Czechoslovak technical education is an almost unknown theme in Czech historical literature. Otakar Franěk devoted a small part of the firs volume of his two-volume *History of the Czech Technical University in Brno* [Franěk 1969] to the German Technical University,[1] where he described mainly the efforts to establish the firs technical school in Brno in the firs half of the 19th century, the development of the Technical College (*Technische Lehranstalt*), later Technical Institute (*Technisches Institut*), during the years 1849–1873, and its transformation into the Technical University (*Technische Hochschule*) in 1873. He also described the efforts to establish the Czech Technical University and its development in the years 1899–1945.

[1] The author is aware of the fact that the name German Technical University used in this article often does not correspond with the school's officia name during its existence. The school was named the k. k. Deutsche Franz Joseph-Technische Hochschule in Brünn only in 1911. The name German Technical University allows one to differentiate this school from the Czech Technical University in Brno. This school bore the attribute "Czech" from its establishment in 1899.

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The history of the German Technical University in Brno is described by Franěk only brief y.

The most important sources are the *Geschichte der Deutschen Technischen Hochschule in Brünn* [Hellmer 1899], by Karl Hellmer, and the *Geschichte der Deutschen Technischen Hochschule in Brünn 1849–1924* [Haussner 1924], by Alfred Haussner. These works appeared on the occasions of the celebration of the 50th and 75th anniversaries, respectively, of the founding of the school. Their main concern is the foundation of the school. From the later period, they mention mainly organizational matters and give only basic information about the mathematicians active at the school until 1924. Information about the later development can be found only through the study programs in the following academic years [AMB].

An exhaustive account of the history of the school is missing in Czech as well as in German literature. Detailed information about the development of branches of study, about the members of faculty, and so on are missing. Hellmer and Haussner mention names of quite a few important scientists who worked at Brno German Technical University, but without giving them any credit for their scientif c achievements. Many of them started their professional careers in Brno and went on to universities in Austria and Germany. In addition to these, other university teachers spent their entire careers in Brno.

Historians of education, science, and technology thus face a diff cult task in compiling a systematic history of this school, which underwent several phases of development in different social conditions in the nationally bicultural Brno.

The possibilities of documenting the development of the German Technical University in Brno are very good, for its complete archive has been preserved, unlike the archives of Prague German Technical University and Prague German University. The archive is stored in the Moravian Provincial Archive in Brno [MZA]. Minutes from faculty meetings from the whole period of the school's existence, f les about the competitions for professors' chairs, f les of assistants and assistant professors, documents pertaining to supply teaching (for the temporarily unoccupied positions), personal f les of the employees since 1880, and many other items have been preserved. The lists of students and graduates are available as well. In the Moravian Provincial Archive, there is also complete correspondence between the school and the Moravian Governance and also part of the correspondence between the school and the Ministry of Education. The only problematic period is the Second World War, for which many important documents are missing.

Having studied the above-mentioned materials, the present author is trying to map the development of mathematics both as a research discipline and as a teaching subject at the Brno German Technical University. Even a preliminary examination of the accessible sources reveals that there were many famous Austrian and German mathematicians working at the University. In the years 1886–1891, Emanuel Czuber[2] was a professor of mathematics in Brno. In 1891 he went to Vienna Technical University. In the same year, Gustav Adolf

[2] Emanuel Czuber (January 19, 1851, Prague–August 22, 1925, Gnigl by Salzburg) studied at the German Technical University in Prague from 1869 to 1874. There he was an assistant and an assistant professor (1876) to Karel Kořistka, Professor of Practical Geometry. From 1875 he taught at the German Oberrealschule, also in Prague. In 1886 he was appointed professor of mathematics in Brno (Czuber was rector of the school in the academic year 1890–1891) and worked there until 1891 when he accepted a call to Vienna Technical University (he was rector in 1894–1895). In 1921 he retired. See [Doležal 1928].

Peschka,[3] Professor of descriptive geometry, accepted a call to the same institution after a 28-year career in Brno.

World-renowned mathematicians occupied both chairs of mathematics in the first two decades of the 20th century. Ernst Fischer[4] worked in Brno as an assistant and an assistant professor (*Privatdozent*) and during 1910–1911 as an associate professor (*ausserordentlicher Professor*) of mathematics. His subsequent appointment as a full professor (*ordentlicher Professor*) of mathematics at Erlangen University was a recognition of the high quality of his scientific work. The topologist Heinrich Tietze,[5] who worked in Brno as a professor of mathematics during 1910–1919, went to Erlangen University in 1919. The prominent mathematician Johann Radon[6] was an assistant to Tietze from April 1911 to April 1912.[7]

In the present article we shall see that the preceding list of famous mathematicians who worked at Brno German Technical University is by no means complete. During the years 1900–1914 the school was, from the point of view of mathematics, a more important place than its provincial status would suggest. This fact will be apparent in our study of the Brno years of Georg Hamel and Richard von Mises, two important representatives of German mathematics of the twentieth century, who early in their careers taught mechanics at the Technical University.

2. BASIC BIOGRAPHICAL DATA

Georg Hamel was born on September 12, 1877, in Düren (Rhineland). In Düren, he attended elementary school and secondary school, which he finished in Aachen. After two years of study at Aachen Technical University, he went to Berlin University in 1897, where Hermann Amandus Schwarz, Immanuel Lazarus Fuchs, Ferdinand Georg Frobenius, and Max Planck were among his teachers. In 1900 he moved to Göttingen University, where he studied under David Hilbert and Felix Klein. He participated in Klein's seminar devoted to selected parts of the theory of elasticity, descriptive geometry, and mechanics.

[3] Gustav Adolf Peschka (August 30, 1830, Jáchymov–August 29, 1903, Vienna) studied from 1846 to 1850 at Prague Polytechnic, where he was an assistant in mechanics and theory of machines during 1852–1857. From 1857 to 1863 he was a professor of these subjects at Lemberg Technical Academy and from 1863 to 1867 in Brno. During 1867–1891 he was a professor of descriptive geometry. In 1891 he went to Vienna Technical University and worked there until 1901. See [ÖBL, 7:435].

[4] Ernst Fischer (July 12, 1875, Vienna–November 14, 1954, Cologne) studied at the Universities of Vienna (he received his doctor's degree there in 1899), Berlin, Zürich, and Göttingen. From 1903 to 1910 he was an assistant of mathematics at Brno German Technical University and he habilitated there in 1904. In 1910 he was appointed associate professor. In 1911 Fischer accepted a call to the University of Erlangen and worked there until 1920. From 1920 to 1938 he taught at Cologne University. See [NDB, 5:183].

[5] Heinrich Tietze (August 31, 1880, Schleinz–February 2, 1964, Munich) studied during 1898–1905 in Vienna, Munich, and Göttingen. In 1904 he received his doctor's degree at Vienna University and habilitated there in 1908. From 1910 to 1919 he was a professor of mathematics in Brno. In 1919–1925 he worked at Erlangen University and from 1925 to 1950 in Munich. See [Perron 1981].

[6] Johann Radon (December 16, 1887, Děčín–May 25, 1956, Vienna) studied at the Universities of Vienna and Göttingen during 1905–1911. After a short period of work in Brno he went to Vienna where he habilitated at the Technical University and the University. From 1919 to the End of World War II he worked at the Universities of Hamburg, Greifswald, Erlangen, and Breslau. From 1947 he taught at Vienna University. His Brno stay is described in [Fuchs 1988].

[7] The details on mathematics teachers can be found in the author's article *Mathematicians at the German Technical University in Brno* [Šišma 2001].

In 1901, Hamel received his doctor's degree under Hilbert in Göttingen for his thesis *Über die Geometrien, in denen die Geraden die Kürzesten sind*. In the same year, he also passed the state examinations for teachers of mathematics and physics. In the academic year 1901–1902, Hamel was an assistant to Klein and participated in Klein's lectures on mechanics. In autumn 1902, Hamel became an assistant to Karl Heun, Professor of theoretical mechanics at Karlsruhe Technical University. In autumn 1903 he habilitated there for mathematics and mechanics [MZA1, Hamel's curriculum vitae].

From October 1905 until the end of September 1912, Hamel worked as a full professor of mechanics at Brno German Technical University. On October 1, 1912, he became a professor of mechanics at Aachen Technical University. He worked there until 1919, when he was appointed professor of mathematics and mechanics at Berlin Technical University. Hamel was elected rector of this school in 1928. Hamel also worked at Berlin Technical University after World War II, and in 1949, he retired. Hamel died on October 4, 1954, in Landshut [Schmeidler 1955].

Very good university preparation enabled Hamel to achieve excellent results in mathematics as well as in mechanics. His doctoral dissertation was devoted to a problem which was formulated by his teacher Hilbert in 1900 and is known as the fourth Hilbert problem. Shortly before his arrival in Brno, he published an article [Hamel 1905] in which an important concept, nowadays known as the Hamel base, appeared for the first time. While investigating problems in mechanics, Hamel achieved a number of important results in the theory of differential and integral equations.

Although he did some important work in mathematics, Hamel was a professor of mechanics, and his scientific work and the textbooks he wrote were devoted primarily to this field. While he may have preferred, perhaps as a result of Hilbert's influence, the axiomatic construction of theories, he felt the necessity of presenting the subject and its concepts from the point of view of a working scientist [Kucharski 1952].

Richard von Mises was born on April 19, 1883, in Lemberg (Lviv) into the family of Arthur von Mises, later an *Oberingenieur* at the Austrian Railway Ministry. His older brother Ludwig (1881–1973) became a world-renowned economist and professor of economics at Vienna University. Both Richard and Ludwig were persecuted in the 1930s for being Jewish, and both were forced to emigrate. Through Switzerland, Ludwig finally arrived in the United States in 1940 [Roeder 1983, 2(2):821–822].

In 1890 the von Mises family moved to Vienna, where Richard went to grammar school in the years 1893–1901. From 1901 to January 1906, he studied mathematics, physics, and engineering at the Technical University of Vienna [MZA2, Curriculum vitae dated November 29, 1905]. In January 1906, he was appointed assistant of mechanics at the German Technical University in Brno. He worked in Brno until 1909, when he was appointed associate professor of applied mathematics at the University of Strasbourg. Officially, he held the position until 1918.

During the First World War, von Mises served in the Austro-Hungarian air force, where he worked as a planner, designer, test pilot, and lecturer. In 1915, he and his colleagues constructed a giant 600-horsepower military plane with an original wing profile. From 1919 to 1920, he worked as a professor of hydro- and aerodynamics at the Technical University in Dresden. In 1920, he accepted a call to the University of Berlin and became the director of the new Institute of Applied Mathematics.

In 1921 von Mises founded the *Zeitschrift für angewandte Mathematik und Mechanik*, and until 1933, he was not only an editor of this journal, but also one of its most active contributors. In the introduction to the first volume, von Mises defined the range of applied mathematics from the point of view of an engineer. This article [Mises 1921] is inspiring even today. In 1933, he emigrated to Turkey and became a professor of mathematics at the University of Istanbul, where he organized and led an important center for applied mathematics. In 1939, he went to the United States. He was a lecturer in mathematics at Harvard, and in 1944, he became a professor of aerodynamics and applied mathematics there. Von Mises died on July 14, 1953, in Boston [Roeder 1983, 2(2):822].

Von Mises is one of the most important applied mathematicians of the 20th century. His research covered an impressive range of topics. Therefore, as in the case of Hamel, we cannot name all his important results here. Before the First World War, he published some important papers devoted to turbines (habilitation thesis) and the dynamics of machines. In 1911, his extensive (about 200 pages) article *Dynamische Probleme der Maschinenlehre* was published in the *Encyklopädie der mathematischen Wissenschaften* [Mises 1911]. Von Mises' preoccupation with fluid mechanics led him into aerodynamics and aeronautics. Already in 1913, he started to lecture on the mechanics of powered flight. His lectures (the first university course on this topic) were published in the book *Fluglehre* in 1918. There were many enlarged editions of this book and it was the basis of *Theory of Flight* [Mises 1945], published in English just before the end of the Second World War [Ludford 1983].

Shortly before his death, von Mises classified his contributions into eight groups: practical analysis, integral and differential equations, mechanics, hydro- and aerodynamics, constructive geometry, probability calculus, statistics, and philosophy. Von Mises was also an authority on the poet Rainer Maria Rilke.

We should not overlook von Mises' quite important contributions to the theory of probability. Early in his career he was aware of the insufficient foundations of the theory of probability and mathematical statistics. Soon after the First World War had finished, he became the author of the famous frequency theory of probability. Although his concept, based on the notion of a random sequence, has not won a place in the mainstream theory of probability, it is still alive and since the 1960s has been developed in mathematical papers at the interface of probability, information theory, algorithmic complexity, and logic [Föllmer 1998].

3. GEORG HAMEL IN BRNO

At the faculty meeting on December 2, 1904, the staff of Brno German Technical University elected a committee that was assigned the task of selecting a Chair of Mechanics to replace the retired Karl Hellmer. Members of this committee were, among others, both of the professors of mathematics at the University. The committee met six times during the following four months, and on March 31, 1905, physics professor Gustav Jaumann delivered the committee's report to the faculty [MZA1].

From the report it is evident that the committee members preferred filling the Chair of Mechanics with a young Austrian specialist. The following people were considered possible candidates: Michael Radakovič (1866–1934) and Anton Lampa (1868–1938) (both associate professors of physics, the former at Innsbruck University and the latter at Vienna University) and Friedrich Hasenöhrl (1874–1915) and Emil Kohl (1862–1924) (both assistant professors at Vienna University). The committee concluded that while these

applicants worked in the field of mathematical physics, their published papers were in no way related to the theoretical foundations of technology. They thus came to the unanimous conclusion that they were unacceptable.

Another possible candidate for this position was Franz Jung (1872–1957) who, after having passed the state examinations for teachers in mathematics and physics, had for seven years been an assistant in mechanics to Professor Franz Stark at the German Technical University in Prague. The committee concluded that, as Jung habilitated only in 1904, he lacked sufficient teaching experience. Jung presented three articles which were evaluated by professors Waelsch and Jaumann. These articles did not have any relation to mechanics, but were about geometrical problems.

The demanding requirements of the committee were also not satisfied by Johann Hermanek, an honorary assistant professor (*Honorardozent*) at Vienna Technical University, Leopold Pfeffer, a secondary school teacher in Brno and formerly an assistant at Vienna Technical University, and J. Dickl, an engineer. The committee did not accept even the last Austrian candidate, Alois Walter, a professor at a secondary school in Graz. He had published 10 articles, but none of them was devoted to technological problems.

The committee came to the conclusion that, in Austria, there was no candidate who possessed all the requirements for a professorship in mechanics at a technical university. The lack of suitable candidates in Austria was, in the opinion of the committee, the result of the preparation of future secondary school teachers, who, after having studied at a technical university for two years, had to continue at a university and thus did not receive a good enough technical education. The people who had studied at technical universities, on the other hand, did not have an adequate theoretical background. The committee believed that suitable applicants could only be found in Germany where university education was organized differently.

German candidates for the vacant position were Hamel, Hans Reissner,[8] Wilhelm Schlink,[9] and Karl Wieghardt.[10] Hamel and Reissner were recommended by Felix Klein, Professor of Mathematics at Göttingen University [MZA1, Klein's letter of December 7, 1904]. Besides Klein, letters of recommendation for Hamel were written by Karl Heun

[8] Hans Jakob Reissner (January 18, 1874, Berlin–October 2, 1967, Oregon) finished his studies at Berlin Technical University in 1897. After a short period of practical work, he continued his studies at Berlin University. Then he worked as a designer at Berlin Technical University and habilitated there for mechanics in 1903. In 1906 he was appointed professor of mechanics at Aachen Technical University. From 1912 to 1936 he worked as a professor of mechanics at Berlin Technical University. In 1936 he emigrated to the United States. Until 1955, he taught at the Technical Universities in Chicago and Brooklyn. See [DBE, 8:233].

[9] Wilhelm Schlink (July 4, 1875, Darmstadt–March 25, 1968, Darmstadt) studied at Darmstadt Technical University in 1893–1897. During 1898–1900 he continued his studies at the Technical University and University in Munich. In 1900 he was appointed assistant of mechanics at Darmstadt Technical University and habilitated there for mechanics in 1903. In 1907 Schlink was appointed associate professor and in 1908 full professor at Braunschweig Technical University. In 1921 he accepted a call to Darmstadt Technical University and worked there until 1949 when he retired. See [DBE, 8:679].

[10] Karl Wieghardt (June 21, 1874, Bergeborbeck (Rheinland)–June 11, 1924, Dresden) studied in 1895–1897 at Hannover Technical University and then at Göttingen University. In the academic year 1899–1900 he was there an assistant (like Hamel). He received his doctor's degree in the academic year 1902–1903. In 1904 he habilitated for mechanics at Aachen Technical University. In 1906 he was appointed associate professor of technical mechanics at Braunschweig Technical University. In 1907 he became a professor of mathematics and mechanics at Hannover Technical University. From 1911 to 1920 he worked at Vienna Technical University. From 1920 he taught at Dresden Technical University. See [DBE, 10:481].

[MZA1, Heun's letter of December 15, 1904], Professor of Mechanics at Karlsruhe Technical University, and by Ernst Brauer, Professor of Theory of Machines [MZA1, Brauer's letter of January 25, 1905]. Hamel presented six published papers, which were evaluated by the individual committee members. In addition to these, Hamel drew the committee's attention to a forthcoming paper in which he introduced the concept of a base, which nowadays bears his name [MZA1, Hamel's curriculum vitae].

The committee report stated that Hamel and Reissner were the best from the quadruple of German candidates, although their specializations were different. Hamel was valued for his excellent university preparation in mechanics and his association for several years with Heun at the Technical University of Karlsruhe. Heun had directed Hamel's scientif c work towards technology. The committee stated:

> He [Hamel] is the youngest of all the candidates but with his knowledge and scientif c achievement, he would be a credit to any university.

The committee members expressed their appreciation for Reissner's practical experience. Unfortunately, this was not considered of great importance in f nding staff who were theoretically competent. Reissner's limited teaching experience was also a disadvantage. Following further discussion by the faculty, a vote was taken with the following result:[11] *Primo loco*: 13× Hamel, 2× Hamel–Reissner, 3× Reissner–Hamel, and 1× Reissner. *Secundo loco*: 18× Reissner, 1× Schlink. *Tertio loco*: 12× Wieghardt–Schlink, 5× Schlink–Wieghardt, 1× Wieghardt, 1× nobody.

In the proposal sent to the Ministry of Culture and Education, the candidates were ordered as follows: Hamel f rst, Reissner second, and Wieghardt together with Schlink third [MZA1]. On October 3, 1905, Hamel was appointed full professor of mechanics at Brno German Technical University with remuneration of 6,400 crowns and additional pay of 960 crowns [MZA3].

There is little information on Hamel's life in Brno. In the archive materials from this period, we can f nd his application of November 27, 1907, in which he asked for remuneration for travelling expenses (500 crowns) for the purposes of attending the IVth International Mathematical Congress in Rome [MZA3]. The answer to this application was negative [MZA4, Minutes dated December 12, 1907]. Thus, Hamel took part in the congress that took place on April 6–11, 1908 at his own expense. We f nd Hamel's name in the list of participants of the Congress in [Atti 1909].

Hamel's continued ties with Germany is indicated by his marriage in August of 1909 in Cologne to Agnes Frangenheim [MZA3]. (The couple would go on to have three daughters [Schmeidler 1955, 2]). The fact that in the academic year 1909–1910, Kurt von Sanden,[12]

[11] Until 1918, the professors for the chairs at Austrian universities were selected in the following way. The choice of the professor was a matter of the competence of the respective faculty. After judging the qualities of each of the applicants, the faculty decided about the ranking of the f rst three places and delivered their proposal to the Ministry of Culture and Education. The minister then chose one of the candidates on the basis of this proposal (not necessarily the one who was put in the f rst place by the faculty) and suggested his nomination to the emperor.

[12] Kurt von Sanden (August 7, 1885, Neustrelitz (Mecklenburg)–1976, Karlsruhe) studied at Karlsruhe Technical University in 1904–1909. In the academic year 1909–1910 he was an assistant to Georg Hamel in Brno. After military service in the navy he worked until 1923 at the Friedrich Krupp AG Germaniawerft in Kiel. In 1923–1926 he was a professor of mechanics and applied mathematics and in 1926–1936 of mathematics and mathematical technics at Karlsruhe Technical University. During 1936–1946 he worked in Krupp AG again. After World War II (1947–1955) he worked at Karlsruhe Technical University. See [Renteln 2000, 279–288].

a recent graduate of Karlsruhe Technical University and a pupil of Heun, worked as his assistant serves as evidence of Hamel's contacts with schools in Germany. Sanden later worked as a professor of mathematics at the Technical University in Karlsruhe and completes the gallery of mathematicians who passed through Brno German Technical University.

During his stay in Brno, Hamel wrote his first textbook on mechanics, which was published under the title *Elementare Mechanik* in Leipzig in 1912 [Hamel 1912a]. This work, which was more than 600 pages long, was devoted not only to the elements of mechanics, but also to a number of its special fields. It was based on his lectures at the Technical University dealing with the elements of statics, dynamics, and hydrodynamics, as well as more advanced problems. From the academic year 1907–1908 on, he conducted a seminar devoted to recent results in mechanics [AMB, the program for school year 1907–1908].

Hamel set forth principles for the axiomatic construction of mechanics in his articles *Grundlagen der Mechanik* [Hamel 1909a] and *Raum, Zeit und Kraft als apriorische Formen der Mechanik* [Hamel 1909b], which were published in 1909. The second article developed themes outlined in a lecture delivered by Hamel at the meeting of the *Deutsche Mathematiker-Vereinigung* in Cologne in September 1908. In 1911 Hamel's work *Zum Turbulenzproblem* [Hamel 1911] was published, containing his reaction to Sommerfeld's lecture at the IVth International Mathematical Congress in Rome and his analysis of the problem of critical velocity.[13]

During his Brno years, Hamel wrote two works on solving linear differential equations. This research was inspired by problems connected to physics and technology. In the first [Hamel 1912b] he analyzed the stability of the solution of such equations. In the second [Hamel 1913], he showed new ways of solving the equation $\ddot{x} + M(t)x = 0$, where $M(t + 2\pi) = M(t)$. This work was published when Hamel was in Aachen but was completed in Brno. We know that Hamel's mathematical expertise was recognized in Brno in the winter term 1911–1912 when he substituted as professor for the Chair of Mathematics II [MZA5].

On October 1, 1912 Hamel was appointed full professor of mechanics at the Technical University in Aachen. The Chair of Mechanics in Brno would remain vacant until 1917.

4. RICHARD VON MISES IN BRNO

As a result of a decree of the Ministry of Culture and Education of October 23, 1905, an assistant's position to the Chair of Mechanics was created at the German Technical University in Brno [MZA6, Minutes dated December 15, 1905]. Nine applicants applied for the position, and on November 29, 1905, Richard von Mises also sent his application to Brno [MZA2]. Although he had not passed the second state examination he stated in his application that he would complete this requirement by January 10, 1906. After that date, he would possess all the prerequisites necessary for the competition. To the application he attached a curriculum vitae, which serves as a valuable source of information about his life up to then [MZA2, Curriculum vitae dated November 29, 1905].

In addition to the usual data, von Mises stated in his curriculum vitae that in 1905, still as a student, he had published an article *Zur konstruktiven Infinitesimalgeometrie der ebenen Kurven* [Mises 1905] in Volume 52 of *Zeitschrift für Mathematik und Physik*. He also drew attention to his practical experience in a machine industry factory. During the 1903 summer holidays, he was employed in such a factory *Vulkan* in Vienna, and from August

[13] Critical velocity is the velocity of fluid flow at which the motion changes from laminar to turbulent flow.

21, 1905 to September 30, 1905 he worked as a volunteer in the workshop of the *Prager Maschinenbau-Actien-Gesellschaft*.

The competition for the assistant's position was closed on December 11, 1905 by Hamel, who evaluated the individual applicants in his final report [MZA2]. Hamel recommended the appointment of von Mises as assistant to the Chair of Mechanics, despite the fact that von Mises had not passed the second state exam yet. Hamel cited von Mises' excellent education and his research publication as evidence of his ability to carry out independent scientific work.[14] Von Mises' three-month practical experience in machine industry also worked to his advantage.

On December 15, 1905, the faculty approved of Hamel's suggestion and recommended that the Ministry appoint von Mises assistant for the period from January 1, 1906 to September 30, 1907 [MZA6, Minutes dated December 15, 1905]. By a Ministry decree of January 3, 1906, von Mises was hired with a yearly salary of 1400 crowns [MZA2].

At the meeting held on January 19, 1906, Hamel informed the faculty that von Mises had successfully passed the second state exam [MZA6, Minutes dated January 19, 1906] and on the recommendation of the faculty, von Mises was appointed a fully qualified assistant by a Ministry decree of February 15, 1906 [MZA2]. On June 21, 1907, the faculty recommended the extension of von Mises' assistant position for the next two years until September 30, 1909 [MZA7, Minutes dated June 21, 1907].

On March 18, 1908, von Mises submitted an application for habilitation in the field of mechanics and the theory of machines and presented his habilitation thesis, *Theorie der Wasserräder*. Von Mises attached his eight already published papers to the application [MZA8]. At the faculty meeting on March 20, a committee (consisting of Alfred Musil, Gustav Jaumann, Georg Hamel, and Leopold Kliment), was established to evaluate this application [MZA4, Minutes dated March 20, 1908].

A problem with von Mises' application resulted from the fact that his rigorous examination at Vienna Technical University, where he had sent his dissertation *Die Ermittlung der Schwungmassen im Schubkurbelgetriebe* on December 18, 1906, was incomplete. Despite this serious obstacle, the habilitation procedure began, and the faculty received the recommendation report of the committee on June 19, 1908. Hamel was responsible for the evaluation of von Mises's habilitation thesis and some of his earlier papers. A positive judgement of the dissertation was presented by Kliment, the Professor of Machine Theory and Machine Construction. Two of von Mises' papers were evaluated by Jaumann. On the basis of these positive reports, von Mises was asked to deliver his habilitation lecture and the compulsory colloquium [MZA4, Minutes dated June 19, 1908]. The faculty continued their examination of the application on June 22, when von Mises presented three possible topics for the habilitation lecture: (1) On the theory of regulators, (2) On the laws of friction, (3) On the unstable elastic balance. After a short discussion, the first topic was chosen [MZA4, Minutes dated June 22, 1908].

The habilitation colloquium took place on July 1, 1908 and two days later the habilitation lecture was delivered to the faculty. The contents of the lecture, which was devoted to the problem of controlling the stability of machine operation, was published in [Mises

[14] Hamel refers to the above-mentioned article *Zur konstruktiven Infinitesimalgeometrie der ebenen Kurven*, which was more than 40 pages long.

1908b]. On July 8, the colloquium and the habilitation lecture were assessed by Hamel, and the faculty recommended the appointment of von Mises as assistant professor for mechanics [MZA8]. Unfortunately, von Mises had not yet received his doctorate from Vienna Technical University. He submitted the doctor's diploma on August 1, 1908 and only then was it possible to conclude the habilitation process [MZA8]. By a decree of the Ministry of November 7, 1908, von Mises was appointed assistant professor for mechanics at the German Technical University in Brno [MZA8].

Even before being appointed assistant professor, von Mises submitted on July 31, 1908, an application to the competition for the designer's position at the Chair of Theory of Machines and Machine Construction to Professor Kliment [MZA9]. This position was connected with the position of an honorary assistant professor responsible for lectures *Enzyklopädie des Maschinenwesens* intended for students of chemical technology. The competition was announced on July 13, 1908, and applications were accepted until August 15. This well-paid position was very attractive and there were 12 applicants for it.

From the report read by Kliment at the faculty meeting on October 8 we learn that during his stay in Brno from May 15, 1906 to July 1, 1907, von Mises worked as a volunteer (apart from his duties at the technical university) at the *Brand & L'Huillier* company (steam engines, pumps, compressors). In connection with "students' practice," however, this was not a suff cient practical preparation for the designer's position. As far as theoretical background was concerned, von Mises was superior to the other candidates (he was the only one with a doctorate and his habilitation had already been concluded), but from the point of view of practice, many of the other candidates were more experienced. Kliment put von Mises among the three best applicants (the other two were Peter Eyermann and Johann Rudolf Solt) and suggested that, as the position was connected also with an honorary assistant professor position, the three candidates should deliver a trial lecture in the f eld of theory of machines for chemists. On the basis of this lecture, the position could be f lled. The faculty did not agree with this proposal, and a committee of six members (including Hamel) was established to select the best candidate [MZA10, Minutes dated October 8, 1908]. On November 30, the committee recommended von Mises for the position [MZA10, Minutes dated November 30, 1908]. By a decree of the Ministry dated December 28, 1908, von Mises was appointed designer for the period from December 1, 1908 to September 30, 1910 [MZA9]. In the winter term of the academic year 1908–1909, von Mises delivered a two-hour lecture *Enzyklopädie der Mechanik und allgemeine Maschinenkunde II. Kurs*. In the summer term, he took over Hamel's lectures devoted to hydrodynamics.

On March 15, 1909, von Mises sent a letter to the faculty, pointing out that his habilitation application of March 1908 contained the theory of machines as one of the subject areas. Therefore he asked for his "venia legendi" to be broadened to include this subject. He stated that in addition to the habilitation thesis he had published three technologically oriented papers [MZA10, Minutes dated March 19, 1909]. Von Mises' application was dealt with by the faculty on March 19, and on the basis of their recommendation, the Ministry approved of broadening Mises' "venia legendi" on April 29, 1909 [MZA9].

In the f rst half of 1909, von Mises took part in a competition to appoint an associate professor of applied mathematics at Strasbourg University. Its results were announced to the faculty by the rector on June 25. On that occasion, Hamel stood up and announced that von Mises had won the f rst place in the competition at the Faculty of Arts of the University

of Strasbourg and that it was therefore highly probable that the Brno German Technical University was going to lose this extraordinarily talented young man, who had earned fame in the scientif c world in just four years [MZA10, Minutes dated June 25, 1909]. He stated with great regret that it was not possible on short notice to make von Mises a competing offer to stay in Brno. However, he expressed his hope that Austria would attract this young talented man back soon.

On July 23, 1909, von Mises informed the rector that he had been appointed associate professor of applied mathematics at Strasbourg and consequently wished to be freed of all duties in Brno. He asked the rector to inform the faculty about his appointment and at the same time he expressed his thanks for the incessant and long–lasting support and especially for the speed of his habilitation procedure [MZA9].

During his Brno years von Mises devoted most of his scientif c work to problems in the theory of machines and mechanics. Shortly after his arrival, in March 1906, he f nished the work *Die Ermittlung der Schwungmassen im Schubkurbelgetriebe*. It was published in October and November in *Zeitschrift des Österreichischen Ingenieur- und Architekten-Vereines* [Mises 1906] and in December, he submitted it as his dissertation thesis at the Technical University in Vienna. In the spring of 1907, von Mises published a critical contribution [Mises 1907] in *Physikalische Zeitschrift*, in which he reacted to the "new foundations" of the theory of turbines in the work of Hans Lorenz from Danzig. This piece stimulated a discussion in the pages of the journal. During this period he also revised and extended his f rst geometrical work and prepared it, as Maurice d'Ocagne had recommended to him, for submission to the *Gauthier–Villars* publishing house.

In 1908, von Mises f nished his habilitation thesis, which was published in the same year in the *B. G. Teubner* publishing house in Leipzig and a year later in the journal *Zeitschrift für Mathematik und Physik* [Mises 1909b]. Here, he proposed to reconcile hydraulics and rational hydrodynamics in the context of "Wasserräder." The "hydraulic hypothesis" introduced there would today surely encounter resistance from journal referees because of its physical tenuousness, but it has served hydraulics, and indeed f uid mechanics, well. Even at the time, the work must have appeared overly mathematical to the empiricists to whom it was directed [Ludford 1983, 281].

In March 1908, while he was in Brno, von Mises started working on the article which was published in 1911 in *Encyklopädie der mathematischen Wissenschaften*.[15] On September 20–25, 1908, Hamel and von Mises took part in the meeting of the *Deutsche Mathematiker-Vereinigung* in Cologne. Von Mises delivered a lecture there devoted to problems of technical hydrodynamics, a work that was published later that year [Mises 1908a].

5. EFFORTS TO APPOINT VON MISES PROFESSOR IN BRNO

Von Mises is mentioned in the archival materials of the Brno German Technical University even after he moved to Strasbourg. He was among the candidates for several competitions for the professorship of mathematics or mechanics until 1919, when he was appointed full professor at Dresden Technical University.

[15] See [SUA, von Mises's curriculum vitae].

Von Mises' name is first found among the candidates for the professorship of mathematics at Brno in 1909. On April 28, 1909, Otto Biermann,[16] Professor of Mathematics, died after a long illness. His early retirement was discussed by the faculty already on March 19. At this meeting, a committee was established which was assigned the task of choosing a suitable candidate for the vacant position (one of the members was Hamel) [MZA10, Minutes dated March 19, 1909]. The committee worked during the whole year of 1909, and the vote for the new professor of mathematics took place on December 17. The situation was to a great extent affected by the fact that the Chair of Descriptive Geometry was also vacant. This chair was vacant from December 1908 after Otto Rupp's[17] death. During 1909 it became apparent that finding an acceptable candidate for the chair would be very difficult. The faculty therefore suggested the appointment of the current Professor of Mathematics (and a very good geometer) Emil Waelsch[18] to the chair. The Ministry agreed with this step, and consequently the second chair of mathematics became vacant. There were now two positions in mathematics that needed to be filled. An evident candidate in the competition for one of these—essentially equivalent—positions was assistant professor Ernst Fischer, who had habilitated at the Brno German Technical University in 1904. Besides Fischer and von Mises, five other people emerged as candidates. Two of these were Heinrich Tietze, assistant professor at Vienna Technical University, and Hans Hahn (1879–1934), at that time an associate professor at Czernowitz University. The committee concluded almost immediately that the two positions should be offered to Fischer and Tietze. Indeed, both were appointed the next year. In the case of von Mises and Hahn, the committee took into account the fact that both of them were only shortly before appointed associate professors at other universities [MZA14].

As was stated earlier, Fischer moved from Brno to Erlangen in 1911, and one of the chairs of mathematics became vacant again. On July 3, a new committee was established, and Hamel was a member once again. The final report of the committee was presented by Tietze to the faculty on January 10, 1912. As far as von Mises and Brno were concerned, the competition was the most important one. Besides von Mises, the candidates for the vacant professorship were: Hahn, still associate professor at Czernowitz University, Lothar Schrutka (1881–1945), assistant professor at Vienna University and Vienna Technical University, Hermann Rothe (1882–1923), assistant professor at Vienna Technical University,

[16] Otto Biermann (November 5, 1858, Těšín–April 28, 1909, Brno) studied at the Universities of Prague and Vienna in 1876–1880. In the academic year 1881–1882 he studied at Berlin University under Weierstraß. In 1883 he habilitated at the Prague German University. During 1883–1885 he was an assistant there, and then he taught at secondary schools. In 1891 he was appointed associate professor and in 1894 full professor at Brno German Technical University. See [MZA11].

[17] Otto Rupp (April 29, 1854, Nová Říše–December 7, 1908, Brno) studied in 1871–1875 at Brno German Technical University, where he was appointed assistant in descriptive geometry to Professor Peschka in 1874. In 1881 he habilitated for projective geometry. In 1892 he was appointed associate professor and in 1896 full professor of descriptive geometry. See [MZA12].

[18] Emil Waelsch (April 9, 1863, Prague–June 5, 1927, Brno) studied in 1880–1884 at the German University and German Technical University in Prague. During 1884–1886 he studied at the Universities of Leipzig and Erlangen where he received his doctor's degree. In the academic year 1892–1893 he studied at Leipzig University again. In 1890 he habilitated at Prague German Technical University where he was an assistant from 1886. In 1895 he was appointed associate professor and in 1898 full professor of mathematics at Brno German Technical University. In 1910 he was appointed professor of descriptive geometry. See [MZA13].

Wilhelm Blaschke (1885–1962), from summer 1911 associate professor at Greifswald University, and Robert König (1885–1979), assistant professor at Leipzig University.

It is evident from the report that the committee preferred the two associate professors, von Mises and Hahn (in that order), while Blaschke was ranked third. Already at this stage, objections to von Mises and Hahn appeared, when Hans Daf nger refused to sign the report [MZA15]. At the faculty meeting, the proposal of the committee was rejected by several professors who preferred the trio Blaschke, Rothe, and Schrutka.

The recommendation of the committee was also rejected by prorector Alfred Haussner, who was also a member of the committee. At the meeting, Haussner did not state any objections to von Mises and Hahn as far as their scientif c work was concerned. Instead he rejected them for collegial reasons—it was better not to nominate them at all than to nominate them with low support from part of the faculty. Haussner did not disclose why some of the faculty opposed von Mises and Hahn, but it was apparently for personal reasons.

The committee's decision was also rejected by Daf nger. In the discussion Waelsch and Hamel expressed support for von Mises and Hahn. Hamel favored these two men for the f rst place, with preference given to von Mises. He suggested Blaschke for the second place and nobody for the third place. Von Mises and Hahn were also supported by professors Eduard Donath and Max Hönig. Kliment declared that he could only consider von Mises for the f rst place. However, out of respect for the views of the faculty, he decided not to support anybody for the f rst place; as for the second place, he suggested the trio Blaschke, Rothe, and Schrutka.

The results of the f nal vote were the following [MZA15]: *Primo loco* 11× Schrutka, Rothe, Blaschke; 6× von Mises–Hahn; 4× von Mises. *Secundo loco* 12× Schrutka, Rothe, Blaschke; 5× von Mises–Hahn; 1× Hahn–von Mises; 3× von Mises; 1× Blaschke. *Tertio loco* 3× von Mises–Hahn; 1× Hahn–von Mises; 3× von Mises; 2× König; 1× von Mises, Hahn, Blaschke.

Three days later, on January 13, Waelsch, Jaumann, Hamel, and Tietze signed a dissenting vote and declared their support for von Mises and Hahn [MZA15], von Mises and Hahn for the f rst place and Blaschke for the second. They also remarked that at the meeting Waelsch and Hamel had expressed their wish to nominate von Mises (although in the ranking they were both put at the f rst place). With respect to the question of personal reasons for rejecting von Mises and Hahn, they wrote that both men were well educated and above reproach in their personal qualities. Hamel and Kliment had worked with von Mises and knew him well, and Donath and Waelsch also had close contact with von Mises. The same view was expressed by Tietze about Hahn on the basis of long-term cooperation and friendship. Reference was made by the authors of the dissenting vote to the positive evaluations of von Mises and Hahn by such personalities as Franz Mertens, Gustav Escherich, and Wilhelm Wirtinger in Vienna, David Hilbert in Göttingen, and Constantin Carathéodory in Breslau.

Hamel wrote about von Mises in his own written statement on this situation:

> [...] Herr von Mises now is the man, who meets, as far as a person can come close to an ideal, all requirements for a teacher of mathematics at a technical university. He is a technician and therefore he knows better than anybody else the needs of technicians; he is productive and a respected scientif c personality; his mathematical competence is recognized by all his colleagues in the f eld.
>
> He combines an outstanding intelligence, which makes him versatile, with a high ability to judge, which enables him to recognize with certainty the valuable things, an ability quite important for a teacher, who has to choose the most necessary features for his listeners. His article recently published in the

> *Encyclopedia* can serve as an excellent proof, revealing these characteristics of his particularly well. The fact that Mr. von Mises was asked by *Geheimrat* Klein in Göttingen and Professor Heun in Karlsruhe to write this very challenging article is certainly a sign of the enormous approval which he has earned in the scientif c world. [...]

Hamel also discussed the other candidates and put Hahn on the same level as von Mises. Towards the end of his report, he stated that his opinion was not subjective - on the contrary, it was supported by all the mathematicians from whom they had requested information.

The faculty acknowledged the dissenting proposal on January 19 [MZA16, Minutes dated January 19, 1912]. The result of the vote that was submitted on January 30 to the Ministry included only a short remark about the dissenting vote. On April 19, Schrutka was appointed associate professor of mathematics.[19]

We f nd the name of von Mises again in 1916 when the professorship of mechanics, vacant since Hamel's departure for Aachen in 1912, was f nally to be f lled. At the faculty meeting on April 13, 1916, von Mises was recommended by professors Friedrich Niethammer, Karl Zickler, Eduard Donath, and Emil Waelsch. In his written proposal [MZA18, Minutes dated April 13, 1916], Waelsch reminded the faculty of von Mises's stay in Brno and informed them about his pedagogical and publication activities after he had left Brno. He also mentioned von Mises' activities in the war. Waelsch remarked that although "Freiherr von Skoda" offered von Mises a position as manager of the newly built aircraft factory in Budapest, he declined this proposal, stating as a reason that he would rather continue with teaching.

In the f nal vote, von Mises was recommended for the f rst place in the competition by 8 members of the faculty, while 26 voted for Theodor Pöschl (1882–1955), associate professor of mechanics at Prague German Technical University. However, Pöschl did not accept the call to Brno (he was appointed full professor in Prague), and hence Alfons Leon (1881–1951), assistant professor at Vienna Technical University, who had ended up second in the competition, was appointed. Leon moved on to Graz Technical University after a short period in Brno in 1918. On March 8, 1918, the faculty nominated Karl Federhofer (1885–1960), assistant professor of the Mining Academy in Leoben, as his successor. He was put at "*primo et unico loco*." On this occasion Waelsch drew attention to von Mises once again. When the vote was taken, Federhofer received twenty-four votes, while only Waelsch voted for the other candidate, von Mises [MZA19, Minutes dated March 8, 1918].

CONCLUSION

Shortly before World War I, two famous German mathematicians, Georg Hamel and Richard von Mises, worked at the German Technical University in Brno. The staff ng of the chairs of mathematics, descriptive geometry, and mechanics at the German Technical University in Brno conf rms the thesis that scientists concentrated in German universities

[19] Lothar Schrutka (June 25, 1881, Czernowitz–February 22, 1945, Vienna) studied in 1899–1903 at Vienna University, where he received his doctor's degree in 1903. During 1905–1912 he was an assistant at Vienna Technical University. He habilitated at Vienna University (1907) and Vienna Technical University (1908). In 1912 he was appointed associated professor and in 1917 full professor at Brno German Technical University. In 1925, Schrutka accepted a call to the Technical University of Vienna and taught there until his tragic death when Vienna was bombarded in 1945. See [MZA17].

and German industry in the Czech lands inclined more and more to an all-German scientif c life. From 1860s on, their scientif c work began to stand out in the scientif c development of the Czech lands. Hamel and von Mises are no exception to this rule, when we consider their personal and scientif c careers, including the attitude toward them at the local German schools.

The years 1905–1912 belong to the most important period in the history of the school from the point of view of teaching mathematics. This is conf rmed by the fact that in 1905, i.e., in the very year when Hamel came to Brno, the *Mathematisch-physikalische Gesellschaft zu Brünn* began its activities. Both Hamel and von Mises participated in the Society. We have only fragmentary information on the activities of this Society. Only the lists of lectures held in the years 1906–1913 published in the *Jahresbericht der Deutschen Mathematiker-Vereinigung* were preserved.[20] From these lists, it follows that of the total of 63 lectures, 11 were delivered by Hamel and 4 by von Mises.

The activity of both men in Brno took place at the beginning of their academic careers. As was the case for other mathematicians at the German Technical University, who worked in Brno for a relatively short period of time, their Brno years were a stepping stone for future work at universities outside the Czech lands.

Hamel started his career as a professor of mechanics at the technical university in Brno and he f nished it at the prestigious technical university in Berlin. He made good use of his experience teaching in Brno to write a textbook on elementary mechanics. His research at this time was devoted to the elements of mechanics, its special problems (e.g., the problem of liquid f ow), and the theory of differential equations. In Brno, Hamel was married and in the years 1909 and 1912, his two oldest daughters were born.

Von Mises came to Brno in 1906, while still a student at the Technical University of Vienna, and three years later he left for Strasbourg. His work in Brno was very important for his career. During this period he investigated problems of pure mathematics only marginally, working primarily in technological applications and mechanics. He returned to Brno again in March 1911, when he delivered a lecture *Über das Oszillationsproblem* at a meeting of the *Mathematisch-physikalische Gesellschaft zu Brünn*. This was shortly before his second unsuccessful attempt to secure a professorship at the German Technical University in Brno. It seems that personal relationships played a role here and outweighed the professional qualities of the candidate. The archive materials do not supply concrete reasons why von Mises (but also Hahn) was unacceptable to a major part of the faculty and we can only speculate whether one reason for this animosity was the self-conf dent behavior of this exceptionally talented young man. A number of other members, in order to be loyal to the rest of the faculty, then voted for other candidates. Von Mises' Jewish origin can most probably be excluded as a potential reason, as the denomination of the candidate played no role in the competitions for chairs at that time and anti-Jewish attitudes can only be found much later at the Brno German Technical University. To conclude with, let us state that the result of the vote taken by the faculty was in several other cases different from the proposal of the committee set up from the specialists in mathematics or related f elds.

This article has documented the lives of two world-renowned scientists during their years in Brno. This period in their careers has not been described before. The history of

[20] See the *Jahresbericht der Deutschen Mathematiker-Vereinigung* **16** (1907), 396–397; **18** (1909), 104–105; **21** (1912), 58–59; **23** (1914), 52–53.

mathematical education at the German Technical University in Brno (and also at the German universities in Prague) offers a number of other topics, which, however, remain to be studied.

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SUA Státní ústřední archiv v Praze (State Central Archive in Prague) MKV/R 1888–1918, 350, Richard von Mises, Personal f le.

MZA Moravský zemský archiv (Moravian Provincial Archive) B 34 Německá technika v Brně (German Technical University in Brno).

MZA1 B 34 640/5 Occupation of Chair of Mechanics, 1904.

MZA2 B 34 604 Richard von Mises—Personal f le V.

MZA3 B 34 573 Georg Hamel—Personal f le.

MZA4 B 34 176 Minutes from the faculty meetings 1907–1908.

MZA5 B 34 648 Substitution for the unoccupied places 1906–1921.

MZA6 B 34 174 Minutes from the faculty meetings 1905–1906.

MZA7 B 34 175 Minutes from the faculty meetings 1906–1907.

MZA8 B 34 604 Richard von Mises—Personal f le II.

MZA9 B 34 604 Richard von Mises—Personal f le IV.

MZA10 B 34 177 Minutes from the faculty meetings 1908–1909.

MZA11 B 34 554 Otto Biermann—Personal f le.

MZA12 B 34 616 Otto Rupp—Personal f le.

MZA13 B 34 631 Emil Waelsch—Personal f le.

MZA14 B 34 640/12 Occupation of the Chair of Mathematics after Professor Dr. Otto Biermann's death (1909).

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